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THE VEGETABLE LEAFMINER, LIRIOMYZA SATIVAE BLANCHARD (DIPTERA: AGROMYZIDAE), IN FLORIDA[1]

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SYNONYMY: LIRIOMYZA SATIVAE BLANCHARD, 1938 (ARGENTINA). HOST OF HOLOTYPE, MEDICAGO SATIVA L.
LIRIOMYZA PULLATA FRICK, 1952 (HAWAII). HOST OF HOLOTYPE, DATURA.
LIRIOMYZA CANOMARGINIS FRICK, 1952 (HAWAII). HOST OF HOLOTYPE, INDIGOFERA.
LIRIOMYZA MINUTISETA FRICK, 1952 (HAWAII). HOST OF HOLOTYPE, 'TOMATO'.
LIRIOMYZA MUNDA FRICK, 1957 (CALIFORNIA). HOST OF HOLOTYPE, "LYCOPERSICUM".
LIRIOMYZA GUYTONA FREEMAN, 1958 (ALABAMA). HOST OF HOLOTYPE, 'BEANS'.
LIRIOMYZA PROPEPUSILLA FROST, 1954 (KANSAS).

INTRODUCTION: LIRIOMYZA SPECIES HAVE PERIODICALLY PLAGUED FLORIDA VEGETABLE AND ORNAMENTAL GROWERS SINCE THE LATE 1940'S. ALTHOUGH NORMALLY PRESENT IN MODERATE NUMBERS, POPULATIONS IN SOUTH FLORIDA HAVE REACHED EPIDEMIC PROPORTIONS IN THE LATE 1940'S, EARLY 1960'S, AND EARLY 1970'S. THE INSECTS THERE SEEM TO HAVE BECOME RESISTANT TO THE INSECTICIDES RECOMMENDED FOR THEIR CONTROL. CURRENTLY LIRIOMYZA SATIVAE BLANCHARD, THE VEGETABLE LEAFMINER, IS CAUSING CONCERN AMONG FLORIDA FARMERS BECAUSE IT IS SO DESTRUCTIVE, NUMEROUS, AND POLYPHAGOUS. DISTRIBUTED THROUGHOUT FLORIDA AND COLLECTED IN VARIOUS REGIONS OF THE AMERICAN TROPICS AND SOUTHERN TEMPERATE REGIONS, THIS INSECT HAS BEEN REARED FROM A NUMBER OF BOTH CULTIVATED AND WILD HOSTS.

HOSTS: CROP PLANTS ATTACKED ARE MAINLY IN THE FAMILIES CUCURBITACEAE, LEGUMINOSAE, AND SOLANACEAE, AS FOLLOWS: CUCURBITACEAE: CITRULLUS VULGARIS SCHRAD. (WATERMELON), CUCUMIS MELO L. (CANTALOUPE), CUCUMIS SATIVUS L. (CUCUMBER), CUCURBITA PEPO L. (SQUASH); LEGUMINOSAE: BAUHINIA (ORCHID TREE), CAJANUS CAJAN (L.) MILLSP. (PIGEON PEA OR CAJUN), CASSIA (SENNA), DESMODIUM (TICK TREFOIL, TICK CLOVER, OR BEGGARWEED), INDIGOFERA (INDIGO), LUPINUS (LUPINE), MEDICAGO SATIVA L. (ALFALFA), MELILOTUS ALBA DESR. (WHITE SWEET CLOVER), PHASEOLUS LUNATUS L. (LIMA BEAN), ALSO 'PINK BEAN' (CALIFORNIA), 'BLACK BEAN' (VENEZUELA), 'POLE BEAN' (GUAM), PISUM SATIVUM L. (ENGLISH PEA OR GARDEN PEA), TRIFOLIUM (CLOVER), VICIA (VETCH), VIGNA REPENS BAKER, VIGNA SINENSIS ENDL. (SOUTHERN PEA OR COWPEA); SOLANACEAE: CAPSICUM ANNUUM L. (PEPPER), CESTRUM, DATURA, LYCOPERSICON ESCULENTUM L. (TOMATO), NICOTIANA TABACUM L. (TOBACCO), PHYSALIS (GROUND-CHERRY), SOLANUM MELONGENA L. (EGGPLANT), SOLANUM TUBEROSUM L. (POTATO), SOLANUM SPP. (NIGHTSHADE). LESS COMMONLY ATTACKED PLANT HOSTS INCLUDE: CRUCIFERAE: BRASSICA (MUSTARD, TURNIPS, CAULIFLOWER, ETC.), RORIPPA (YELLOW CRESS), LEPIDIUM (PEPPER-WEED OR PEPPER-GRASS); MALVACEAE: ANODA, GOSSYPIUM (COTTON), HIBISCUS ESCULENTUS L. (OKRA), SIDALCEA; UMBELLIFERAE: APIUM GRAVEOLENS L., VAR. DULCE PERS. (CELERY), DAUCUS CAROTA L., VAR. SATIVA DC (CARROT), PETROSELINUM CRISPUM NYM. (PARSLEY); EUPHORBIACEAE: RICINUS COMMUNIS L. (CASTOR-BEAN); COMPOSITAE: AGERATUM (AGERATUM), ASTER (ASTER), BIDENS (SPANISH NEEDLE), CALENDULA (CALENDULA), CHRYSANTHEMUM (CHRYSANTHEMUM), DAHLIA (DAHLIA), EUPATORIUM (THOROUGHWORT OR BONESET), GALINSOGA, GERBERA (GERBERA DAISY), HELIANTHUS (SUNFLOWER), LACTUCA SATIVA L. (LETTUCE), LIPOCHAETA, SONCHUS (SOWTHISTLE), TAGETES (MARIGOLD), VERBESINA, ZINNIA (ZINNIA); CARYOPHYLLACEAE: GYPSOPHILA (GYPSOPHILA); SCROPHULARIACEAE: ANTIRRHINUM (SNAPDRAGON); HYDROCOTYLACEAE: HYDROCOTYLE (WATERPENNYWORT OR NAVELWORT); PLANTAGINACEAE: PLANTAGO (PLANTAIN OR RIBWORT); PASSIFLORACEAE: PASSIFLORA (PASSION-FLOWER); MORINGACEAE: MORINGA OLEIFERA LAM. DUE TO CONFUSION IN THE IDENTIFICATION OF L. SATIVAE AND CLOSELY RELATED SPECIES, SOME OTHER HOSTS WHICH HAVE BEEN RECORDED FOR L. SATIVAE NEED TO BE CONFIRMED.

IDENTIFICATION: "VERY SMALL SPECIES, WING LENGTH FROM 1.3 MM IN MALE TO 1.65 MM IN FEMALE; FRONS AND ALL ANTENNAL SEGMENTS BRIGHT YELLOW; ORBITS YELLOW BUT HIND MARGIN OF EYE BLACK, WITH VTE ON BLACK GROUND AND VTI AT MARGIN OF BLACK AND YELLOW; MESONOTUM BRILLIANTLY SHINING BLACK; MESOPLEURA LARGELY YELLOW BUT VARIABLY BLACK ON LOWER HALF; LEGS: COXAE AND FEMORA BRIGHT YELLOW, TIBIAE AND TARSI ONLY SLIGHTLY DARKER, MORE BROWNISH" (SPENCER, 1973). THE STRONGLY SHINING SURFACE OF THE DORSUM OF THE THORAX, THE LARGELY YELLOW FEMORA, THE SHORT FINE HAIRS ON THE APICAL SEGMENT OF THE ANTENNA (FIG. 7), AND THE ENTIRELY YELLOW TOP OF THE HEAD BETWEEN THE EYES (EVEN ALONG THE EYE MARGINS), AS SHOWN IN FIG. 2, USUALLY WILL SEPARATE L. SATIVAE FROM RELATED SPECIES, BUT IN A GROUP OF FLIES CONTAINING SO MANY SIMILAR SPECIES AS LIRIOMYZA THE ONLY DECISIVE CHARACTERS ARE TO BE FOUND IN PREPARATION AND EXAMINATION OF THE MALE GENITALIA BY AN EXPERT. THE AEDEAGUS (FIG. 8, TAKEN FROM SPENCER, 1973, AGROMYZIDAE OF FLORIDA, FIG. 264-265, AS L. MUNDA) IS THE MOST DISTINCTIVE PART.

DISTRIBUTION: L. SATIVAE IS ONE OF THE COMMONEST SPECIES OF AGROMYZIDAE IN SOUTHERN FLORIDA, INCLUDING THE KEYS, AND OCCURS THROUGHOUT MOST OF THE REMAINDER OF THE STATE ON A MUCH SMALLER SCALE. IT IS WIDESPREAD THROUGHOUT THE BAHAMA ISLANDS AND THE ANTILLES, INCLUDING CUBA, JAMAICA, AND BARBADOS, AND IT OCCURS IN SOUTH CAROLINA, THE GULF STATES, AND CALIFORNIA. IT ALSO IS RECORDED FROM TENNESSEE AND OHIO,

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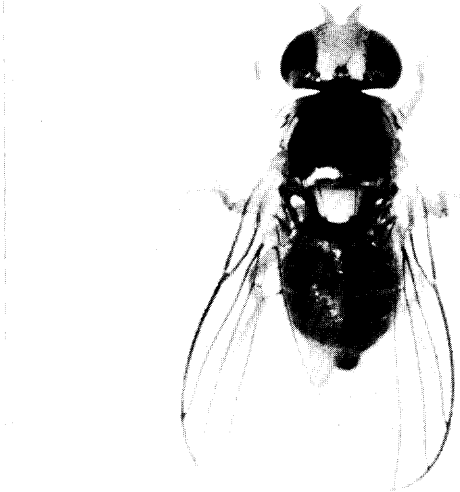

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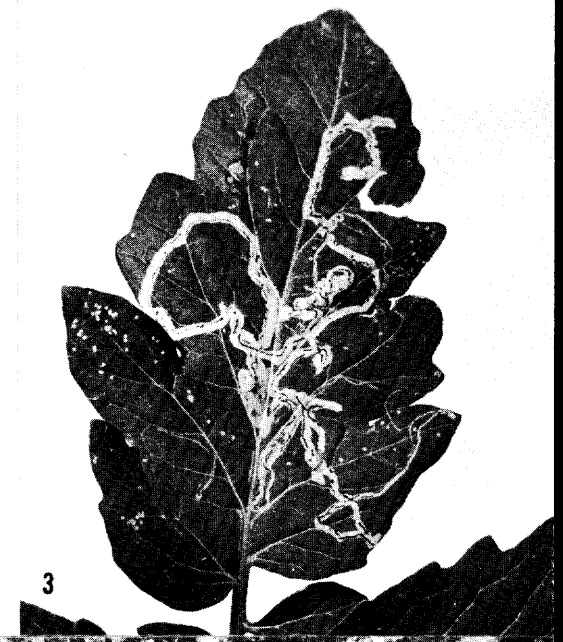

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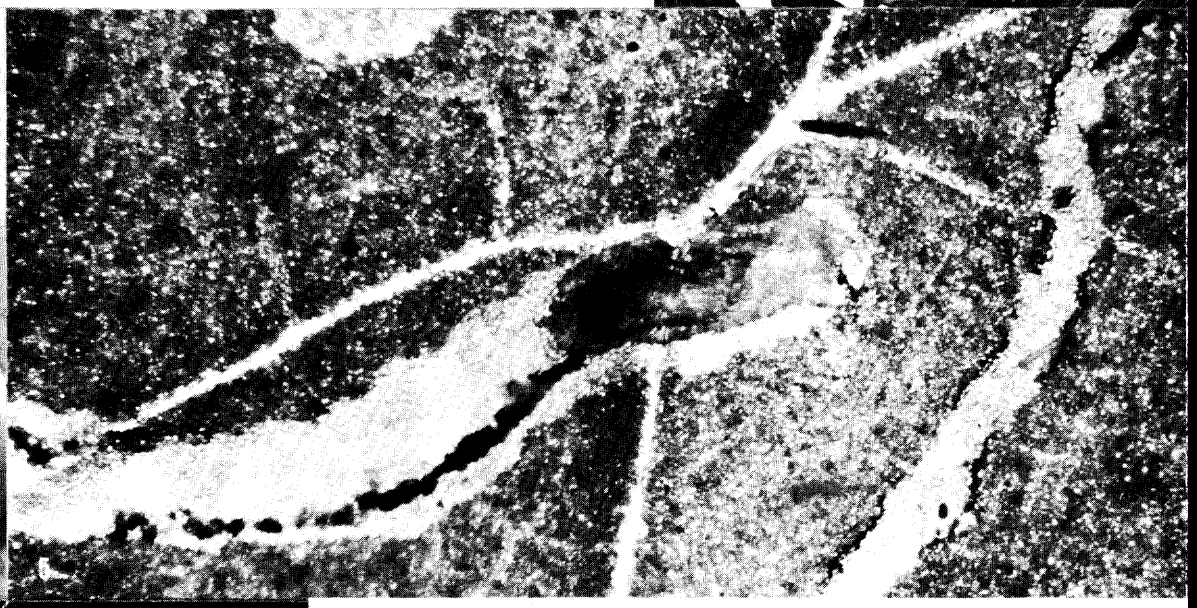

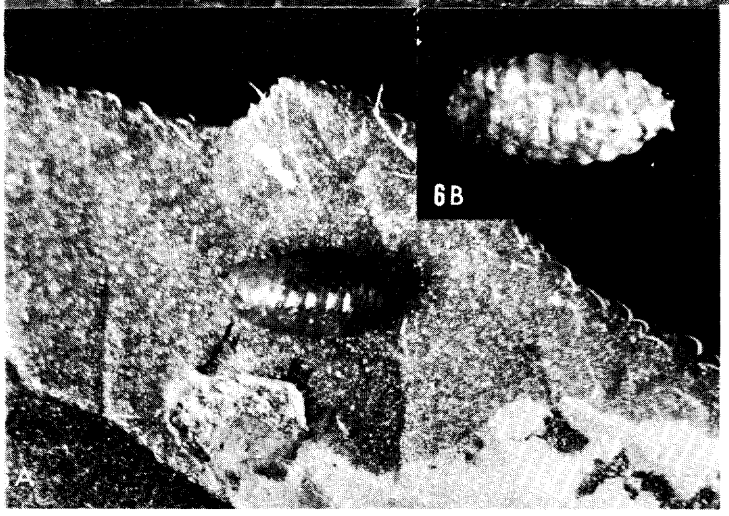

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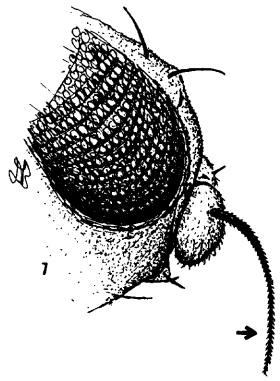

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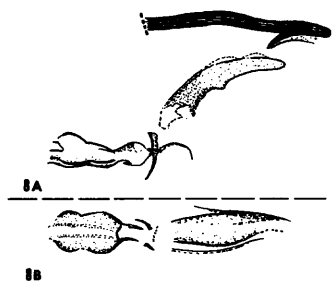

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LIRIOMYZA SATIVAE BLANCHARD. FIG. 1, ADULT FEMALE, LATERAL VIEW; FIG. 2, ADULT FEMALE, DORSAL VIEW; FIG. 3, SERPENTINE LEAF MINE, WITH FECAL TRAIL, IN BEAN LEAF; FIG. 4, STIPPLE MARKS IN SAME LEAF; FIG. 5, LARVA INSIDE LEAF MINE; FIG. 6A, PUPARIUM NEAR TERMINAL END OF MINE FROM WHICH LARVA EMERGED; FIG. 6B, PUPARIUM, MORE ENLARGED; FIG. 7, LATERAL VIEW OF HEAD, SHOWING ANTENNA WITH PUBESCENT ARISTA; FIG. 8A, MALE AEDEAGUS, SIDE VIEW; FIG. 8B, SAME, VENTRAL VIEW.

BUT THE NORTHERN LIMIT OF ITS RANGE REMAINS TO BE ESTABLISHED, DUE IN PART TO CONFUSION ABOUT RECORDS FOR SEVERAL STATES WHICH MAY OR MAY NOT REFER TO THIS SPECIES. IT HAS BEEN RECORDED FROM VENEZUELA, ARGENTINA, AND PERU, AND FROM HAWAII, GUAM, AND TAHITI. THE LATTER RECORDS PRESUMABLY REPRESENT RELATIVELY RECENT INTRODUCTIONS. ABSENCE OF RECORDS FROM OTHER PACIFIC ISLANDS SUGGESTS THAT THE SPECIES IS NOT GENERALLY DISTRIBUTED IN THE PACIFIC AREA.

BIOLOGY: ADULTS MAY BE OBSERVED ON LEAVES OF HOST PLANTS WHERE THE FEMALES REPEATEDLY PUNCTURE THE LEAF SURFACES AND FEED ON THE SAP EXUDING FROM THE WOUNDS (FIG. 1, 2, 4). MALES APPARENTLY LACK STRUCTURES TO PUNCTURE THE LEAVES; THEY MAY FEED AT WOUNDS PRODUCED BY THE FEMALES. THE PUNCTURES ALSO SERVE AS OVIPOSITING SITES FOR GRAVID FEMALES. ALTHOUGH THE PUNCTURES ARE SOMETIMES NUMEROUS ENOUGH TO GIVE THE LEAF A STIPPLED APPEARANCE NEAR ITS APEX AND MARGINS, USUALLY LESS THAN 1% OF THE PUNCTURES WILL CONTAIN VIABLE, MICROSCOPIC EGGS (WOLFENBARGER, 1947). THE DAMAGE MOST COMMONLY OBSERVED IS THE SERPENTINE MINE WHICH USUALLY APPEARS IN THE UPPER LEAF SURFACE 3-5 DAYS AFTER OVIPOSITION (FIG. 3). THE LARVA IS A LATERALLY COMPRESSED, LEGLESS, HEADLESS MAGGOT (FIG. 5). IT IS WHITE OR YELLOWISH AND SOMETIMES HAS DARKLY COLORED INTESTINAL CONTENTS. AS THE LARVA MOLTS AND INCREASES IN SIZE, THE MINE BECOMES WIDER. IN THE LARGER PARTS OF THE MINE, LARVAL FRASS USUALLY IS EVIDENT AS SEVERAL BLACK STRIPS ALTERNATING IN THEIR DISTRIBUTION ALONG THE SIDES OF THE MINE (FIG. 3). TYPICALLY, THE LARVA FEEDS AND RESTS LYING ON ITS SIDE; WHEN IT TURNS OVER INSIDE THE TUNNEL, THE FECES ARE DEPOSITED ALONG THE OPPOSITE SIDE OF THE MINE.

THE LARVA FEEDS BY EXTRUDING THE SICKLE-LIKE, BLACK MANDIBLES AND RASPING AWAY THE LEAF MESOPHYLL WITH A SERIES OF SHORT, DOWNWARD MOTIONS. THE LARVA FEEDS ACTIVELY FOR APPROXIMATELY A WEEK. THEN, IT USUALLY CUTS A SEMICIRCULAR HOLE IN THE END OF ITS MINE AND EMERGES TO PUPATE. FEW HEALTHY LARVAE PUPATE INSIDE THE LEAF MINE. THE SHINY GOLDEN BROWN PUPARIUM (FIG. 6) MAY ADHERE TO THE FOLIAGE OR MAY BE FOUND IN THE UPPER SOIL LAYERS AROUND THE HOST PLANT. IN 7-14 DAYS ADULTS EMERGE. THEY MATE AND CAN LAY FERTILE EGGS WITHIN 24 HOURS AFTER EMERGENCE. THE ENTIRE LIFE CYCLE CAN BE COMPLETED IN 21-28 DAYS, ALTHOUGH UNDER FAVORABLE CONDITIONS, DEVELOPMENT MAY BE ACCELERATED. MANY GENERATIONS CAN BE COMPLETED EACH YEAR. PEAK PEST NUMBERS GENERALLY COINCIDE WITH WARM, DRIER WEATHER AND AVAILABILITY OF HOST PLANTS.

DAMAGE AND ECONOMIC SIGNIFICANCE: THE VEGETABLE LEAFMINER DIRECTLY DAMAGES ITS HOST BY STIPPLING AND MINING THE LEAVES. LEAF WOUNDING CREATES HABITATS FOR INVADING BACTERIAL AND FUNGAL PLANT PATHOGENS. MINING LARVAE UNDOUBTEDLY AFFECT THE HOST'S PHOTOSYNTHETIC EFFICIENCY BY DESTROYING CHLOROPHYLL-BEARING TISSUE. HEAVILY MINED LEAVES SOMETIMES HAVE NEARLY 100% OF THEIR MESOPHYLL REMOVED. ORNAMENTAL CROPS USUALLY ARE NOT SALEABLE, SINCE THE UNSIGHTLY STIPPLES AND LEAF MINES DESTROY THE PLANTS' AESTHETIC APPEAL (POE AND SHORT, 1975). LEAF CROPS, SUCH AS LETTUCE, MAY HAVE THEIR YIELDS DRASTICALLY REDUCED BY HEAVY AGROMYZID INFESTATIONS. EFFECTS OF LARGE AGROMYZID POPULATIONS ON MARKETABLE VEGETABLE YIELDS HAVE NOT BEEN WELL DOCUMENTED.

ON TOMATO, SECONDARY PROBLEMS OF PLANT STRESS, MOISTURE LOSS, OR SUN SCALD OF FRUIT DUE TO ABSENCE OF SHADING FOLIAGE MAY OCCUR. IN HEAVILY MINED CROPS, ACCUMULATIONS OF MINES, LARVAE, AND PUPAE MAY NECESSITATE MORE TRIMMING, CLEANING, AND CULLING BEFORE THE PRODUCE IS MARKETED. IN POTATOES, YIELD APPEARS TO BE UNAFFECTED BY LEAFMINER INFESTATIONS (WOLFENBARGER, 1954), WHEREAS IN TOMATOES, YIELDS SOMETIMES MAY BE AFFECTED (WOLFENBARGER AND WOLFENBARGER, 1966).

POPULATION MANAGEMENT:

A. MONITORING INSECT NUMBERS. LEAFMINERS MAY BE DETECTED BY SEVERAL METHODS. FREQUENT OBSERVATIONS OF SUSCEPTIBLE PLANTS WILL INDICATE THE PEST'S PRESENCE, PARTICULARLY IF STIPPLED OR MINED LEAVES ARE FOUND. ADULTS MAY BE DETECTED BY SWEEPING FOLIAGE WITH AN INSECT NET OR BY TRAPPING THEM ON 3" x 5" BRIGHT YELLOW CARDS (CUT FROM POSTER BOARD OR PAINTED CARDBOARD) STAPLED ONTO A WOODEN STAKE. THE SURFACES OF THE CARD ARE SPRAYED OR PAINTED WITH 'TAC-TRAP'® OR SOME STICKY MATERIAL BEFORE PLACING THE TRAP IN THE FIELD. THE NUMBER OF ADULTS CAPTURED ON A SERIES OF CARDS AFTER 24 HOURS INDICATES THEIR RELATIVE ABUNDANCE IN THE FIELD. TRAPPING SHOULD BE REPEATED AT LEAST WEEKLY AND PEST NUMBERS RECORDED FOR FUTURE REFERENCE. THE VALUE OF THIS TECHNIQUE SHOULD BE DEMONSTRATED FOR EACH CROP AFFECTED BY LEAFMINERS. EARLY DETECTION AND MONITORING OF ADULT MINERS CAN LEAD TO IMPROVED POPULATION MANAGEMENT THROUGH PRECISION APPLICATION OF APPROPRIATE REMEDIAL MEASURES.

B. CULTURAL CONTROL. WHEN ORNAMENTAL AND VEGETABLE CROPS ARE NOT PRESENT IN THE FIELDS, LEAFMINER POPULATIONS SOMETIMES CAN BE FOUND ON A VARIETY OF COMMON LANDSCAPE PLANTS AND PARTICULARLY BROAD-LEAVED WEEDS. THESE PLANTS PROBABLY SERVE AS RESERVOIRS FOR PESTS INITIALLY INFESTING A NEWLY PLANTED ORNAMENTAL OR VEGETABLE FIELD. DESTRUCTION OF ALL BROAD-LEAVED WEED HOSTS, NEAR THE PLANTING AREA AT LEAST A MONTH PRIOR TO SEEDING OR TRANSPLANTING, WOULD ELIMINATE MANY POTENTIAL PESTS OR AT LEAST DELAY THEIR APPEARANCE IN THE FIELDS IF THEY MIGRATE FROM DISTANT AREAS.

REMOVAL OR DESTRUCTION OF ALL CROP RESIDUES FROM THE GROWING AREA ALSO WILL HELP REDUCE THE PEST POPULATION. BURYING CROP RESIDUES IN THE SOIL WILL PREVENT EMERGENCE OF NEARLY 100% OF THE VIABLE LARVAE AND PUPAE.

SOME PLANT VARIETIES APPEAR TO BE RESISTANT TO LEAFMINER ATTACK. CELERY VARIETY #214 SEEMS TO BE HIGHLY ATTRACTIVE TO ADULT LIRIOMYZA, AND THE PLANT'S LEAVES FREQUENTLY ARE RIDDLED WITH MINES. CONVERSELY, CELERY VARIETY #16-24 IS LESS ATTRACTIVE TO ADULTS; MINES ARE FAR LESS FREQUENT, ALTHOUGH THERE IS NO EVIDENCE OF ANTIBIOSIS. A SIMILAR EXAMPLE OF RESISTANCE CAN BE FOUND IN CHRYSANTHEMUMS WHERE VARIETY 'YELLOW ICEBERG' IS HIGHLY SUSCEPTIBLE WHEREAS 'IMPROVED RIVALRY' APPEARS RESISTANT.

C. NATURAL MORTALITY. SEVERAL TAXA OF PARASITIC HYMENOPTERA HAVE BEEN REARED FROM FLORIDA L. SATIVAE LARVAE AND PUPAE IN VARIOUS WILD AND CULTIVATED HOSTS. MANY OF THESE PARASITES HAVE BEEN DETERMINED TO GENUS ONLY BECAUSE SOME OF THE FLORIDA SPECIES ARE STILL UNDESCRIBED. THE IDENTIFIED HYMENOPTERA INCLUDE: BRACONIDAE: OPIUS DIMIDATUS (ASHM.), OPIUS SP., LYSIPHLEBUS SP.; PTEROMALIDAE: HALTICOPTERA CIRCULUS (WALKER), HALTICOPTERA PATELLANA (DALM.); EULOPHIDAE: ACHRYSOCHARELLA SP., ACHRYSOCHARIS SP., CHRYSOCHARIS

PARKSI CWFD., CHRYSOCHARIS SP., DEROSTENUS VARIIPES CWFD., DEROSTENUS SP., DIGLYPHUS INTERMEDIUS (GIRAULT); CYNIPIDAE: GANASPIDIUM SP., HEXACOLA SP. MORE BRACONIDAE AND CYNIPIDAE ARE REARED FROM LEAFMINER PUPARIA, WHILE CHALCIDOIDS ARE ASSOCIATED MORE WITH LEAFMINER LARVAE.

PARASITIZED LARVAE EVENTUALLY BECOME IMMOBILE IN THEIR MINES. THE LARVA MAY BECOME BLOATED OR BLACKENED AS THE PARASITE DEVELOPS INTERNALLY. PARASITIZED LARVAE THAT SUCCESSFULLY PUPATE MAY DO SO INSIDE THE LEAVES OR OUTSIDE. PUPARIA PARASITIZED BY BRACONIDAE USUALLY ARE DARKER BROWN OR BLACK AS A RESULT. ALL PARASITE LARVAE OBSERVED TO DATE ARE LEGLESS, HEADLESS, WHITE, AND ROUND IN CROSS-SECTION AS OPPOSED TO THE LATERALLY FLATTENED LEAFMINER LARVAE. ONLY ONE LARVA DEVELOPS PER HOST. CHALCIDOIDS AND BRACONIDS PUPATE IN THE REMAINS OF THEIR HOSTS; THE PARASITES' PUPAE ARE GLOSSY BLACK AND ARE NOT COVERED BY SILK.

BIOLOGICAL INFORMATION ON ALL PARASITE SPECIES MENTIONED ABOVE IS VERY INCOMPLETE; SOME MAY BE HYPERPARASITES. REARING STUDIES AND PARASITE EXPERIMENTS, WHERE FLIES AND PARASITES ARE EXPOSED TO PESTICIDES, SUGGEST THAT EXCESSIVE USE OF SOME INSECTICIDES MAY FAVOR FLY POPULATION BUILD-UP BY ELIMINATING THE PARASITES. AT LEAST 50% OF THE LEAFMINERS IN 16 VARIETIES OF UNSPRAYED GARDEN VEGETABLES WERE PARASITIZED. CELERY THAT IS NOT SPRAYED DURING THE 2 WEEKS PRIOR TO HARVEST CAN HAVE UP TO 95% OF THE LEAF MINES PARASITIZED; CELERY SPRAYED ACCORDING TO CURRENT GROWER PRACTICES HAS FEWER THAN 1% OF ITS MINES PARASITIZED.

D. PESTICIDES. CURRENT RECOMMENDATIONS FOR LEAFMINER POPULATION CONTROL INCLUDE ORGANOPHOSPHORUS CHEMICALS ON LEAFY VEGETABLES, TOMATOES, AND CELERY. DIMETHOATE, AZINPHOSMETHYL, PARATHION, DIAZINON, AND NALED HAVE BEEN WIDELY USED, AND, ALTHOUGH INSECTICIDE RESISTANCE HAS NOT BEEN DEMONSTRATED IN THE LABORATORY, FIELD POPULATIONS ARE NOT ADEQUATELY CONTROLLED BY THESE MATERIALS.

APPLICATIONS OF CHEMICALS FOR LEAFMINER CONTROL SHOULD PROVIDE FOR ADEQUATE WATER TO COMPLETELY SOAK ALL MINED FOLIAGE AND PERMIT THE TOXICANT TO PENETRATE TO THE LARVA IN ITS MINE. WITH MARGINALLY EFFECTIVE CHEMICALS, APPLICATION OF LOW VOLUME SPRAYS HAS RESULTED IN THE BUILD-UP OF EXCESSIVELY LARGE POPULATIONS.

ORNAMENTAL PLANTS AND CUT FLOWER CROPS MAY BE TREATED WITH GRANULAR SYSTEMIC INSECTICIDES SUCH AS ALDICARB, DISULFOTON, AND PHORATE OR SPRAYED WITH MONOCROTOPHOS OR OXYDEMETON METHYL. SYSTEMIC GRANULES, WATERED IN THOROUGHLY AND INCORPORATED INTO PLANT TISSUE, PROVIDE CONTROL OF MINING LARVAE FROM 3-6 WEEKS.

THE ULTIMATE MANAGEMENT STRATEGY IS TO USE LESS SUSCEPTIBLE CULTIVARS IN WEED-FREE FIELDS AND TO AVOID SPRAYING WITH CHEMICALS AS MUCH AS POSSIBLE TO ALLOW PARASITES TO BIOLOGICALLY CONTROL THE MINER POPULATIONS. PLANTS OTHER THAN ORNAMENTALS USUALLY CAN WITHSTAND POPULATIONS IN FOLIAGE IN EARLY SEASON WITHOUT LOSS OF YIELD DURING LATE SEASON. PERMITTING POPULATIONS OF PARASITES TO BECOME ESTABLISHED DURING EARLY GROWTH AND INTEGRATING OTHER PESTICIDES ONLY AS NEEDED FOR DISEASE OR LARVAL CONTROL WILL HELP TO MANAGE THE INSECT POPULATIONS.

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